Coalbed Methane Resources in Colombia*

Mario Garcia-Gonzalez[1]

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[1]Geology, Universidad Industrial de Santander, Bucaramanga, Colombia (mgarciag@uis.edu.co)

Abstract

A preliminary evaluation of the coal-bed methane (cbm) resources of Colombia indicates that there are at least 8 regions with large cbm potential. The main coal-bearing formations of Colombia range in age from Maastrichtian to Eocene and the coal ranks varies from semianthracite to sub-bituminous. The cbm resource in the main coaly regions of Colombia has been calculated in 17 TCF.

The largest cbm potential is located in the Cesar and Rancheria basins. In the Rancheria Basin the Cerrejón Formation of Paleocene age contains up to 55 coal seams of sub-bituminous and bituminous rank with vitrinite reflectance (Ro) values between 0.4 to 0.8%. Coal seams of the Cerrejón Formation present an excellent lateral extension and a large net-coal thickness of more than 50 meters. These parameters allow expectation of a large cbm resource.

In the Cesar Basin the Barco-Cuervos Formation of Paleocene age also presents a large coal resource with thick coal seams (from 1 to 8 meters) of sub-bituminous and bituminous rank (Ro 0.5 to 0.8%). The cbm potential has been evaluated using hydrous pyrolysis (HP) experiments indicating an excellent potential.

The Bogota Plateau in the Eastern Cordillera is a large area of 3,000 km^2 with 9 coalfields. The Guaduas Formation of Maastichtian to Paleocene age is present in numerous synclinal structures that are the main target for cbm exploration. The coal rank is low to high volatile bituminous, and the Ro values vary between 0.5 and 1.5%. The cbm potential was evaluated using desorption experiments and HP indicating a good cbm potential on the location and stratigraphic position.

The Guachinte-Ferreira Formation of Oligocene to Miocene age in the Cauca Basin is characterized by sub-bituminous coals (Ro 0.4 to 0.7%) with excellent hydrogen index that explains the large gas generation potential as demonstrated by HP tests. A cbm resource of 2 TFC has been calculated for this basin.

The Lower Magdalena Basin presents several large coal deposits in the Cienaga de Oro and Cerrito formations of Oligocene and Miocene ages. These deposits are characterized by sub-bituminous (Ro 0.4 to 0.5%) coals with net coal thicknesses ranging from 16 to 28 meters which contain biogenic cbm gases. Other regions with potentially large cbm potential are the Catatumbo Basin, the Llanos Foothill Basin, the Middle Magdalena Basin, and the Cauca-Patia Basin.

COALBED METHANE RESOURCES IN COLOMBIA

MARIO GARCÍA GONZÁLEZ
mgarciag@uis.edu.co

Research Group on Hydrocarbons and Coal Geology
UNIVERSIDAD INDUSTRIAL DE SANTANDER

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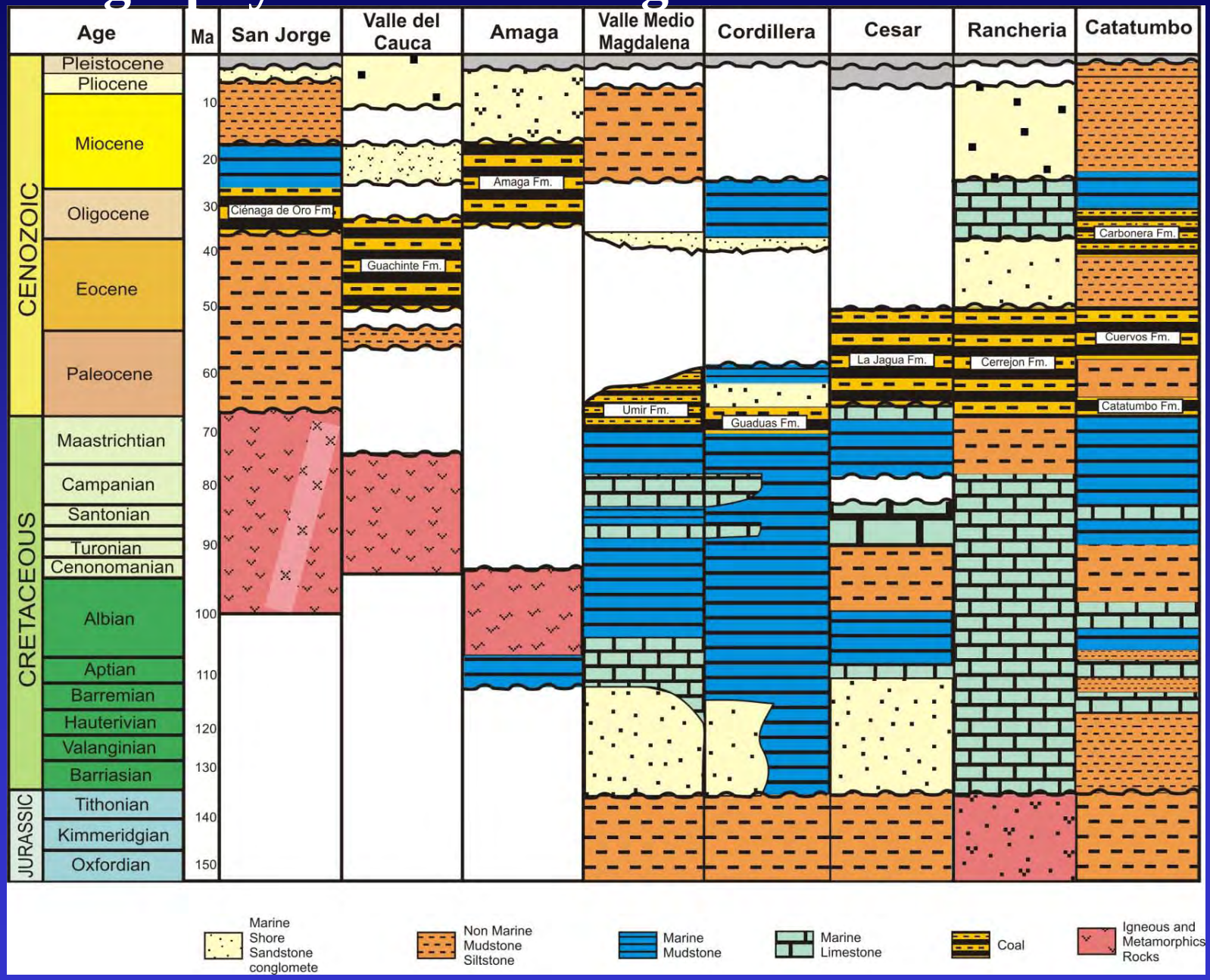
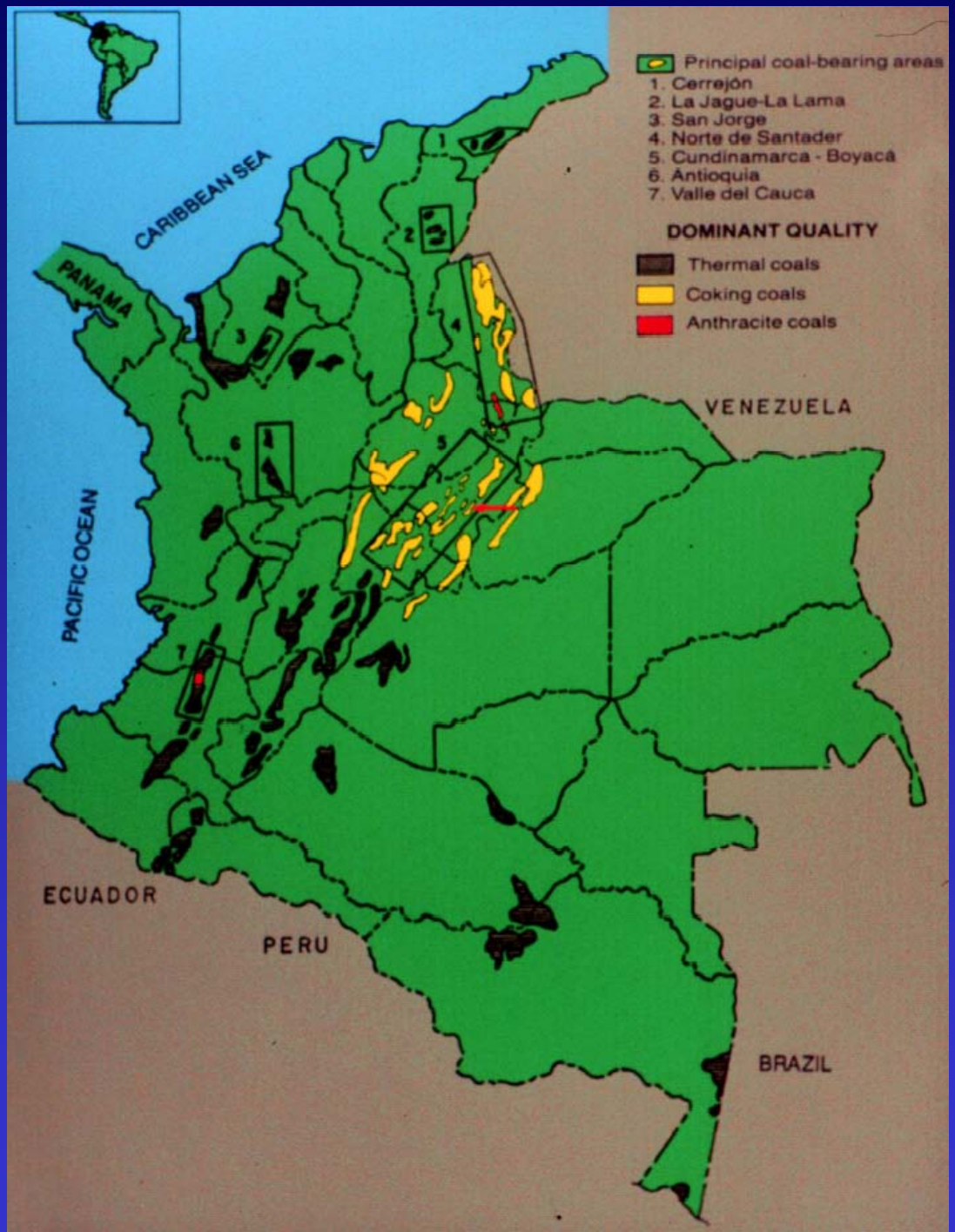
Methodology used to calculate Coalbed methane resources

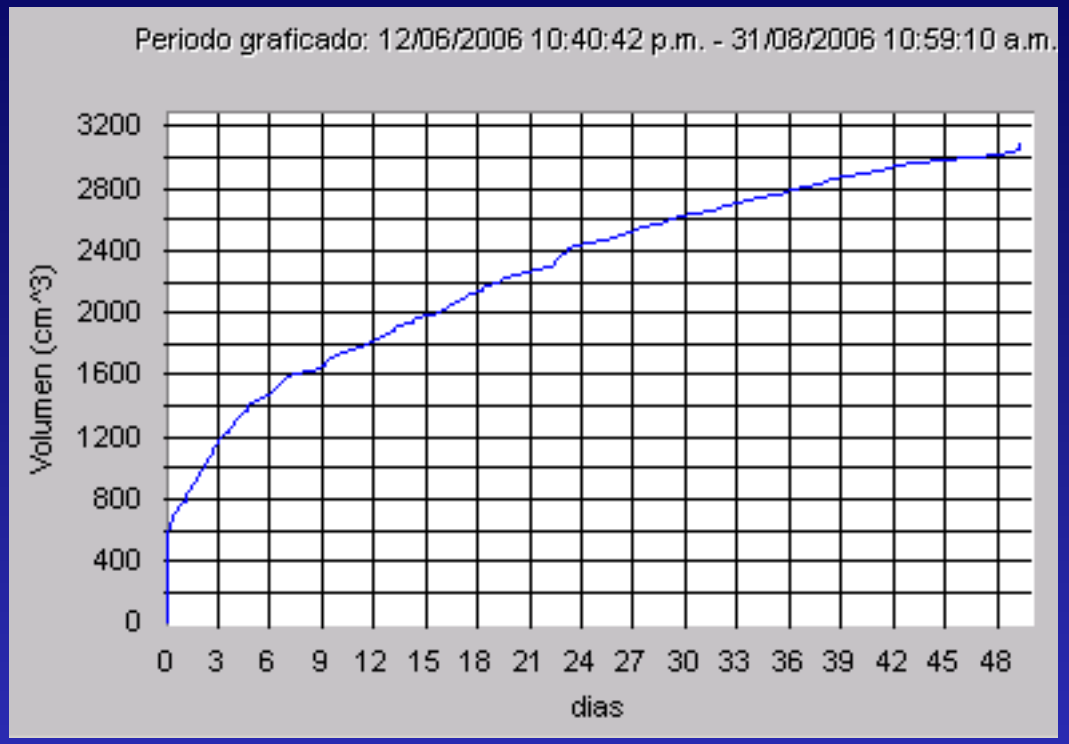
- Stratigraphy of the coal-bearing formations
- Coal rank and coal quality
- Coal resources
- Coal desorption tests
- Isothermal adsorption tests
- Hydrous pyrolysis
- Geochemical modeling

Stratigraphy of Coal-bearing Formations in Colombia



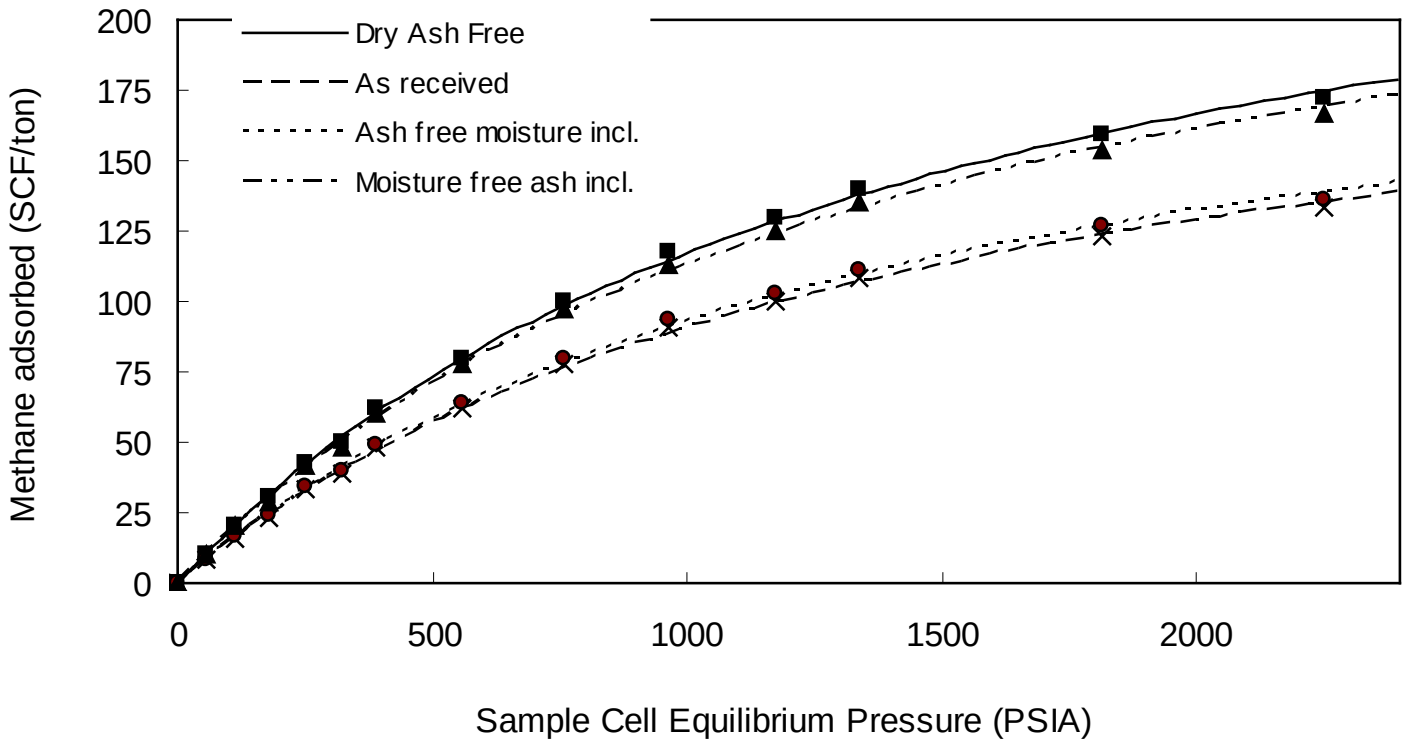


Coaly regions in Colombia with Coalbed methane potential

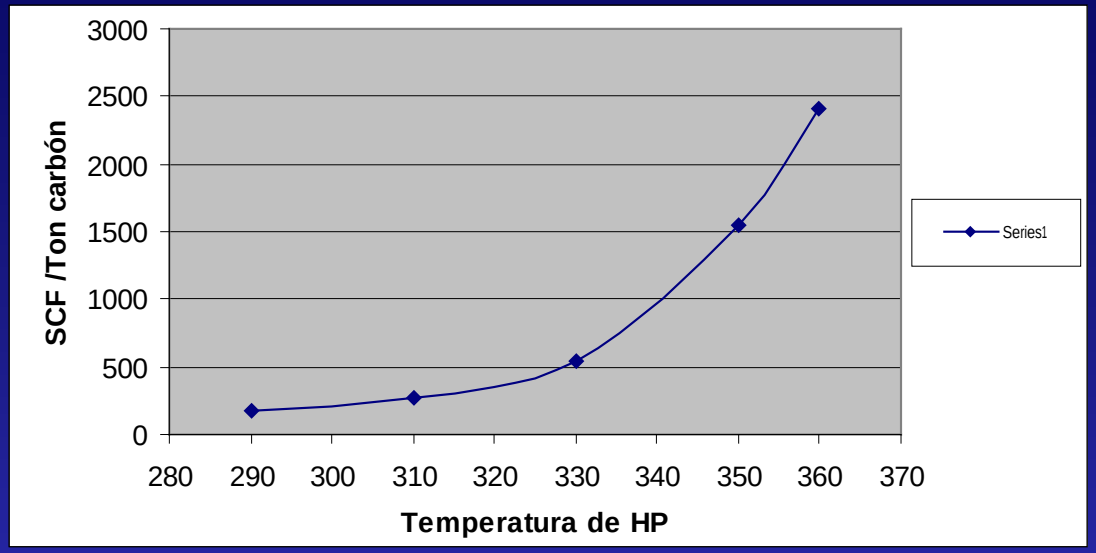


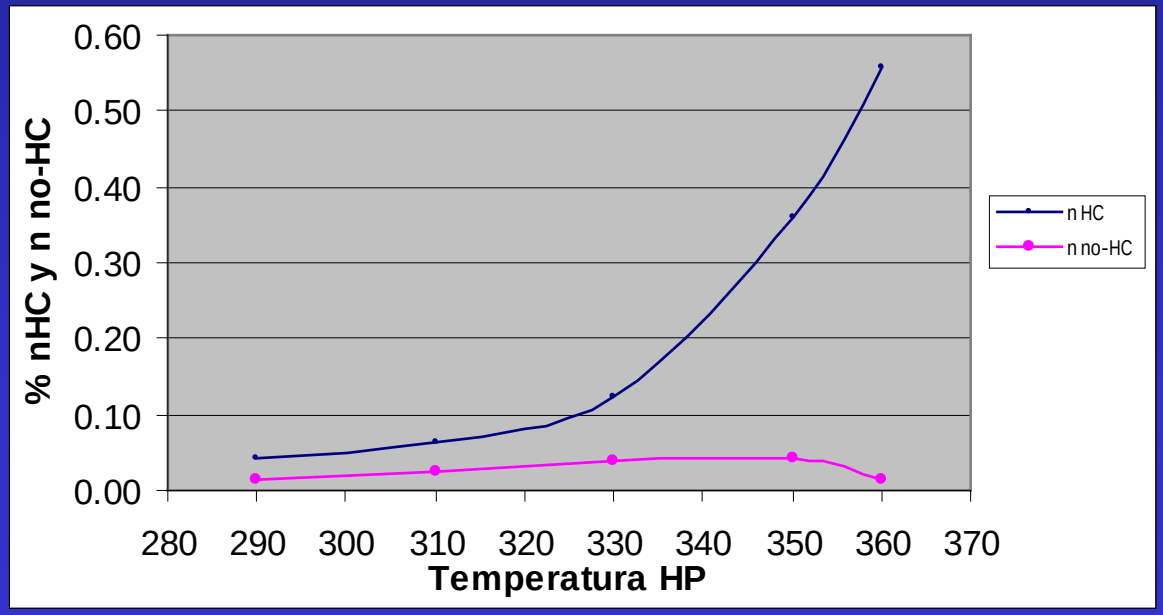
Coal desorption test using computer-controlled canister

Isothermal desorption curves, Guaduas Formation Coal



Hydrous Pyrolysis of immature coal samples





The Guaduas Fm. Coal Shows a great gas generation potential; as indicated by HP experiment, where it generated up to 2400 scft gas/Ton coal at an Ro value of 1.5%. The generated gases were Mainly HC gases

Geochemical Modeling

- Burial History
- Thermal history
- Kinetic of oil to gas reaction
- Calibration of the geochemical model

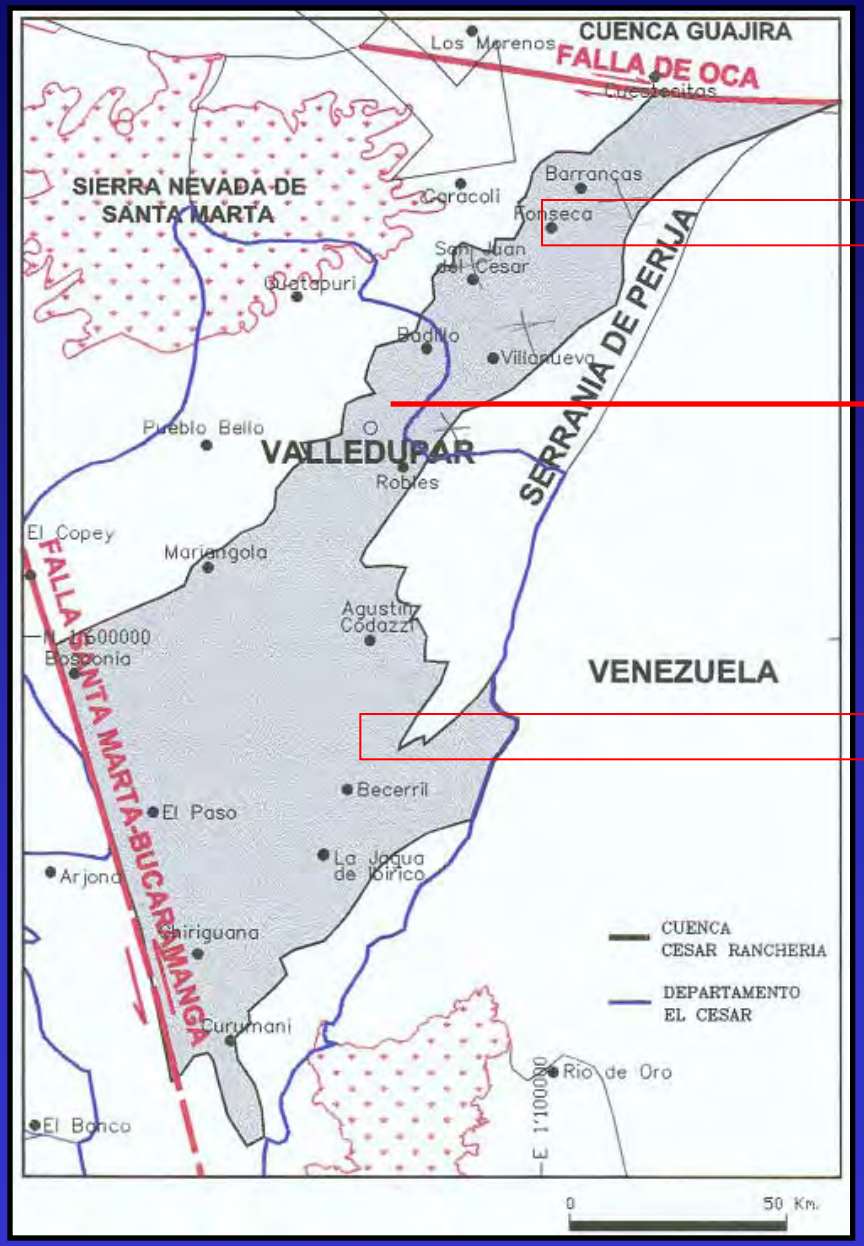
CBM Resources

Coal rank:
Sub-bituminous to Bituminous
CBM resource

Cerrejón: 2.8 TCF

La Jagua-La Loma: 2 TCF

Cesar-Ranchería Basin



RANCHERIA

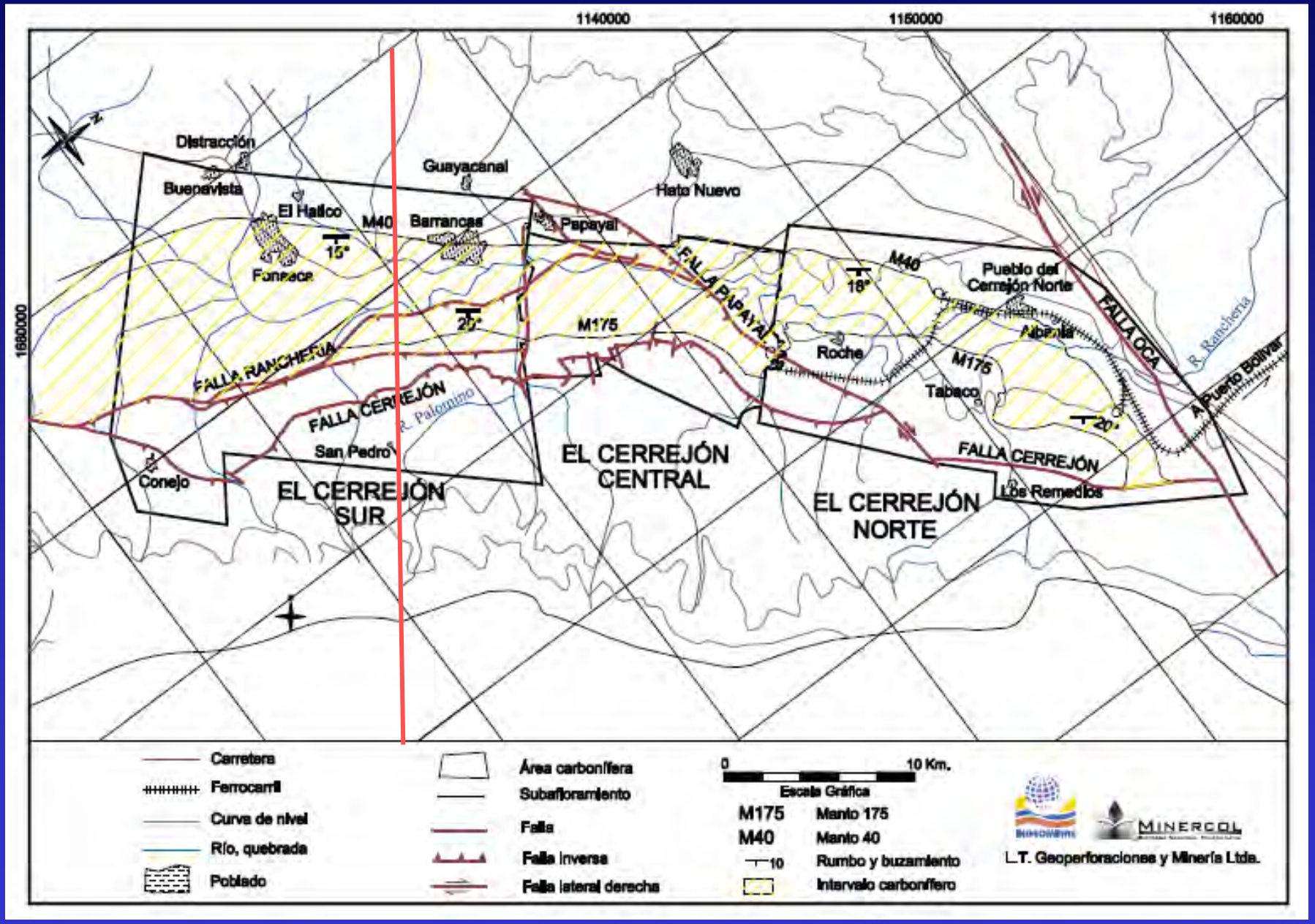
SUB-BASIN

The Valledupar uplift split the basin into sub-basin

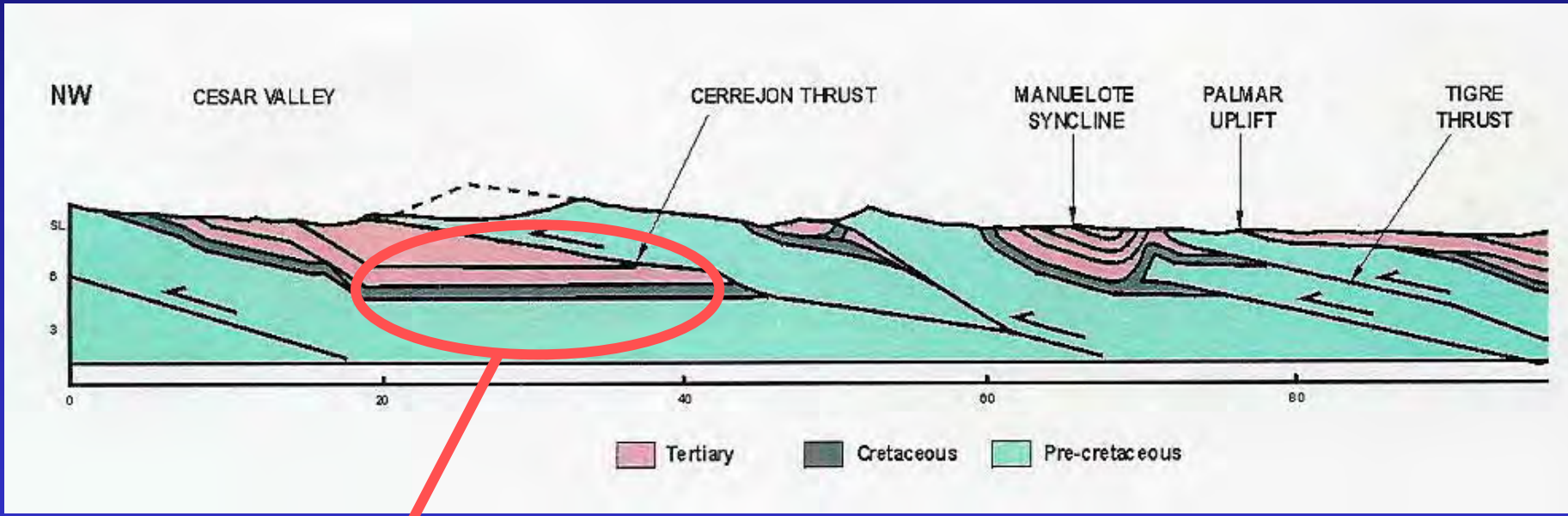
CESAR

SUB-BASIN

Cerrejón Coal field, Ranchería Basin



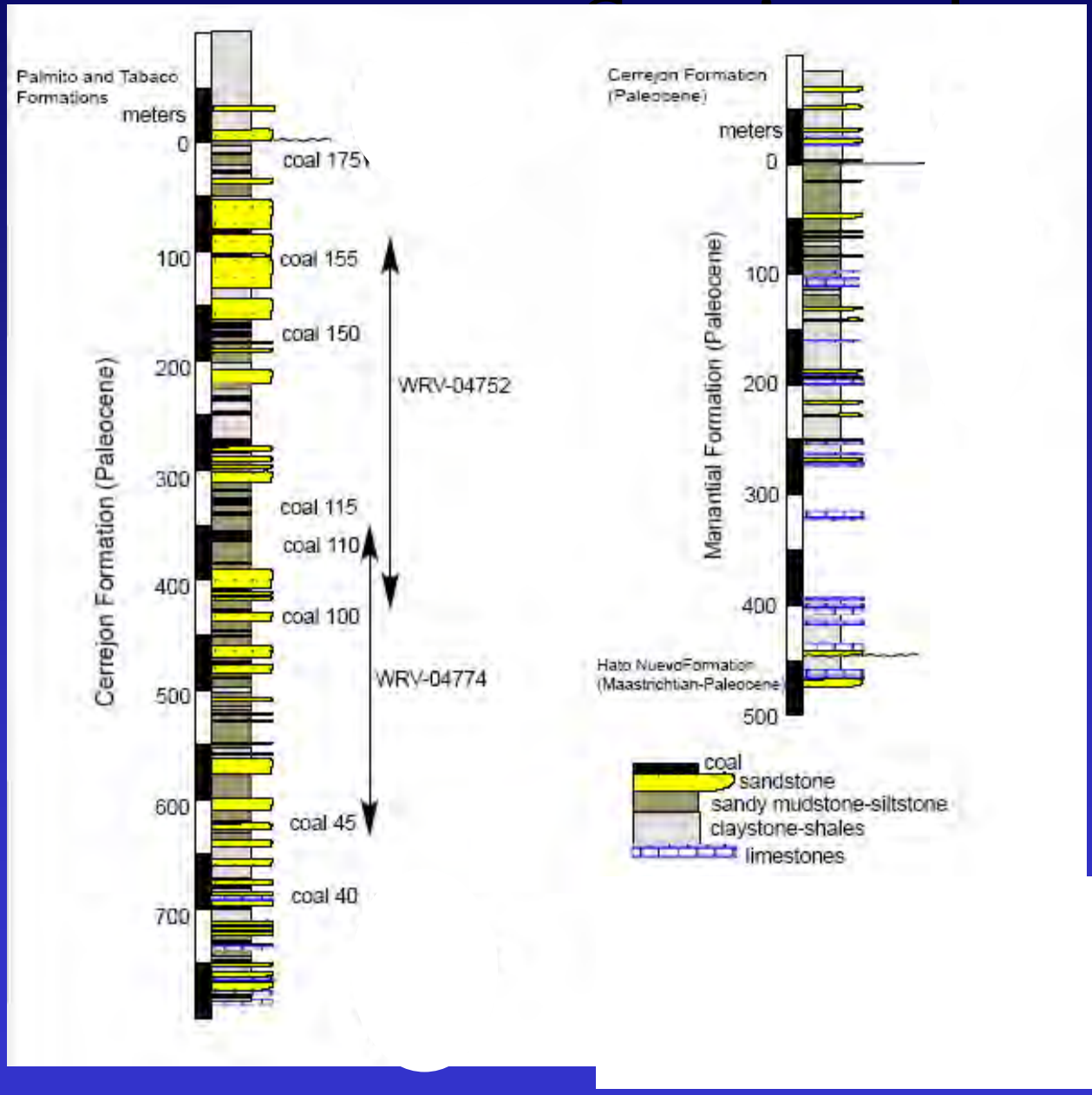
Cerrejón Thrust Fault, Rancherría Basin



Sub-thrust Gas kitchen

After Kellogs & Bollini, 1982

Cerrejón Stratigraphic Column

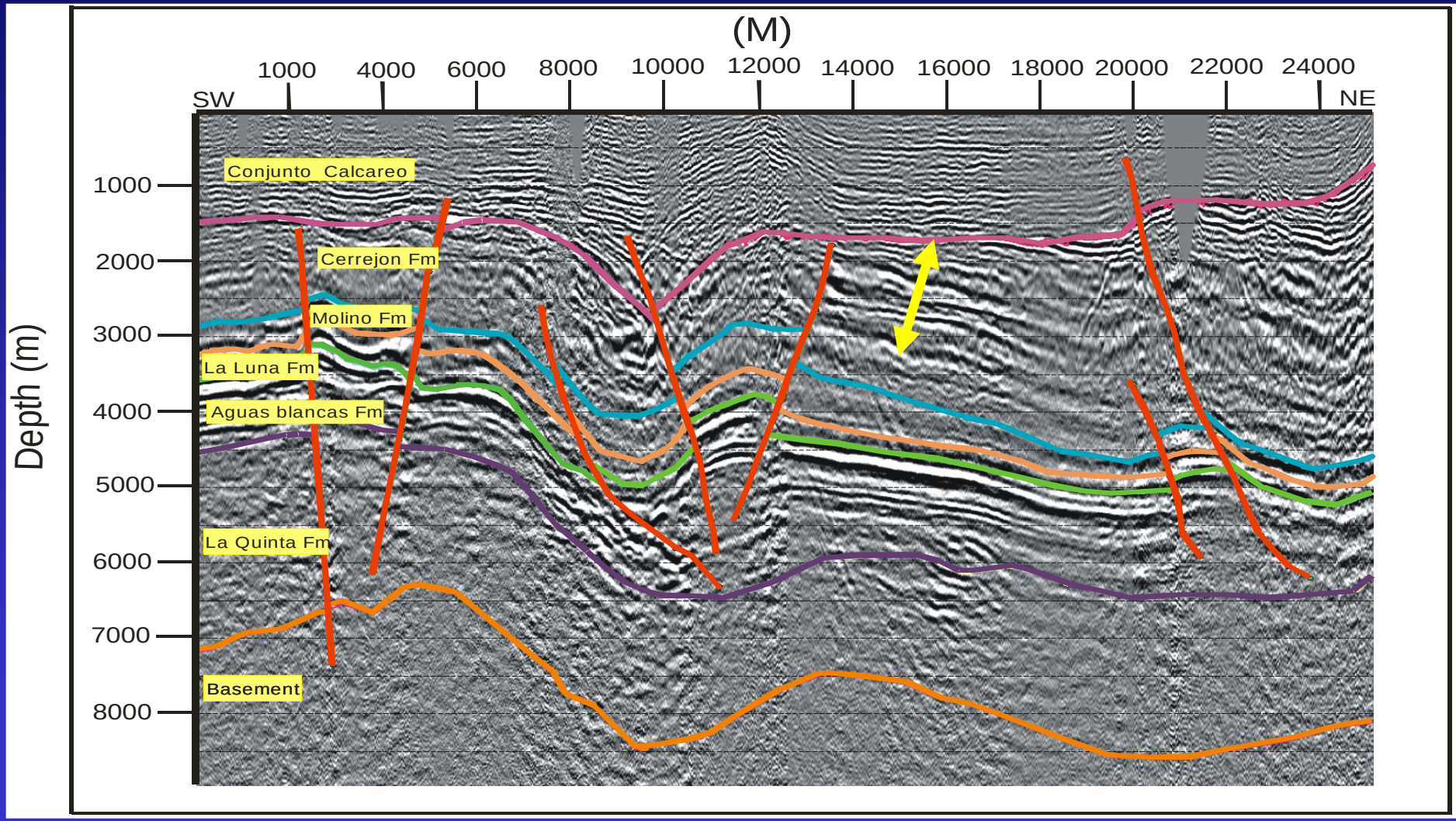


Net coal thickness 110 meters

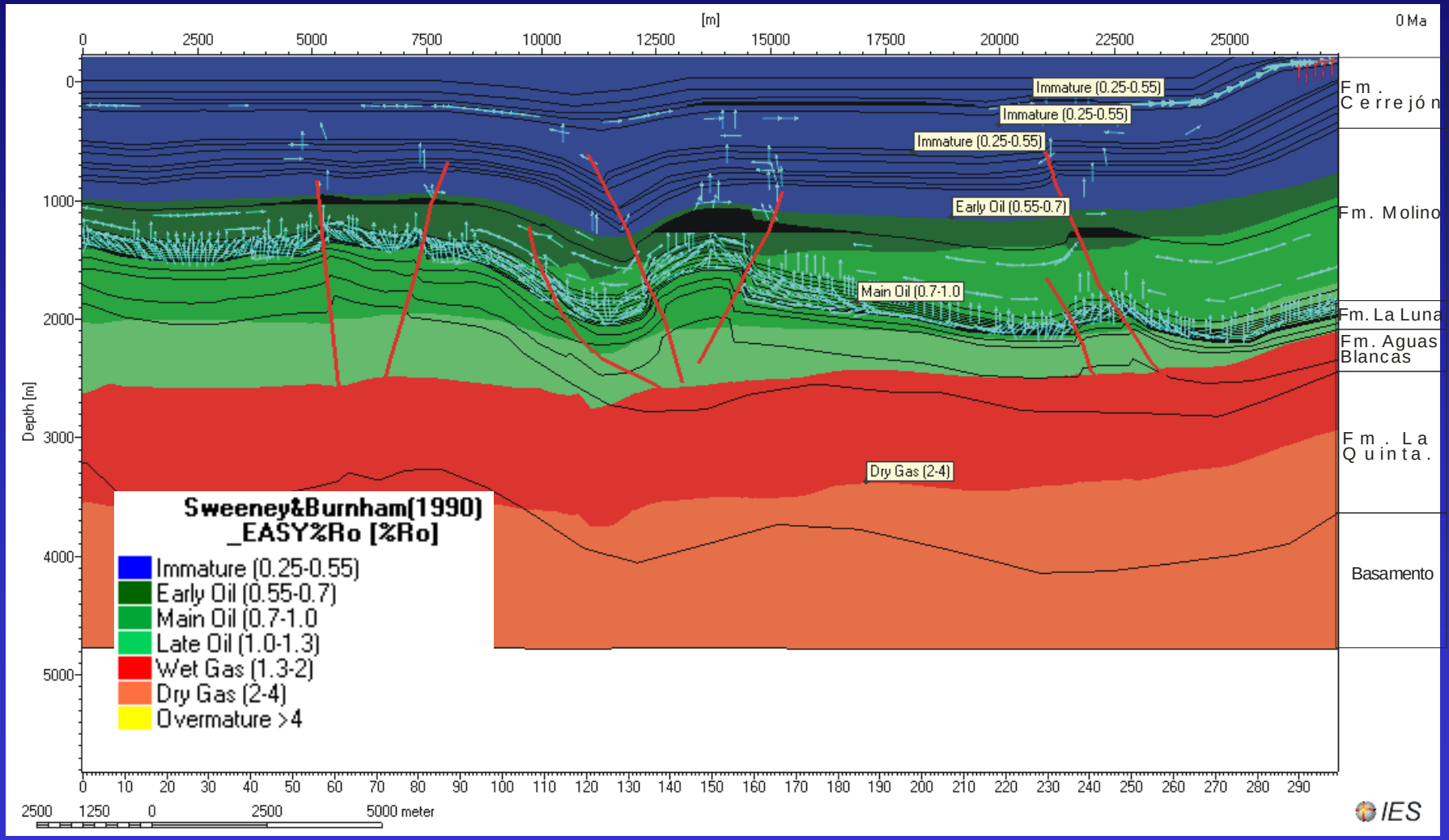
Coal rank Sub-bituminous

After Bayona et al. 2004

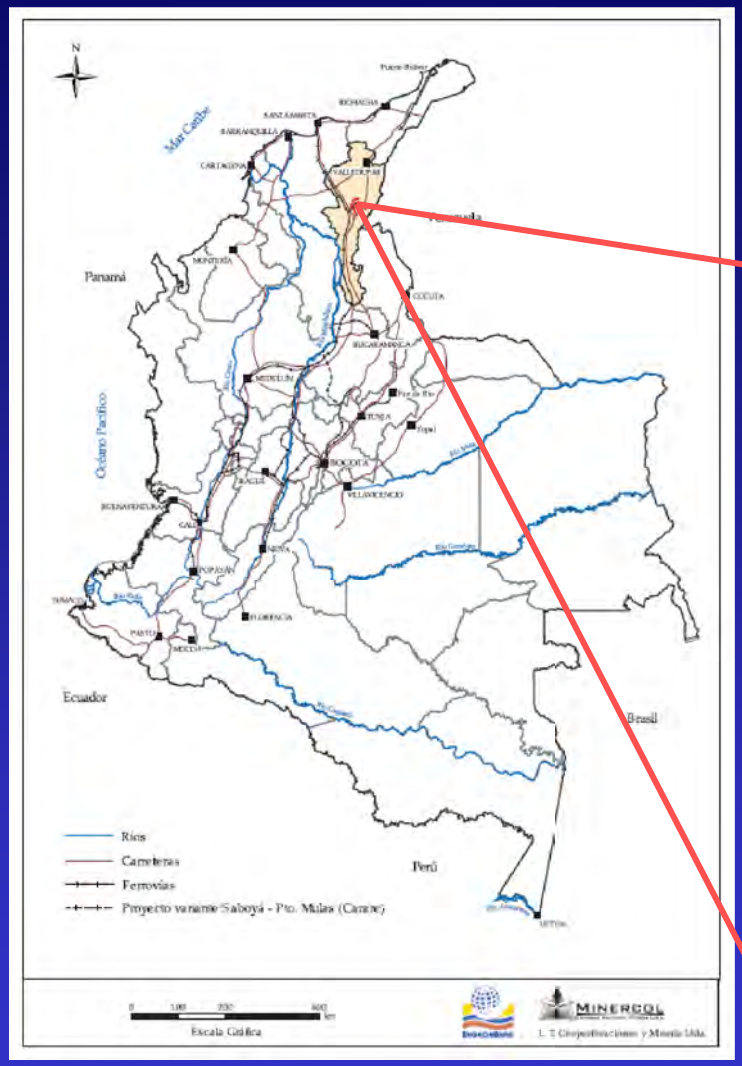
SEISMIC LINE CV 89 1100.
RANCHERIA SUB-BASIN

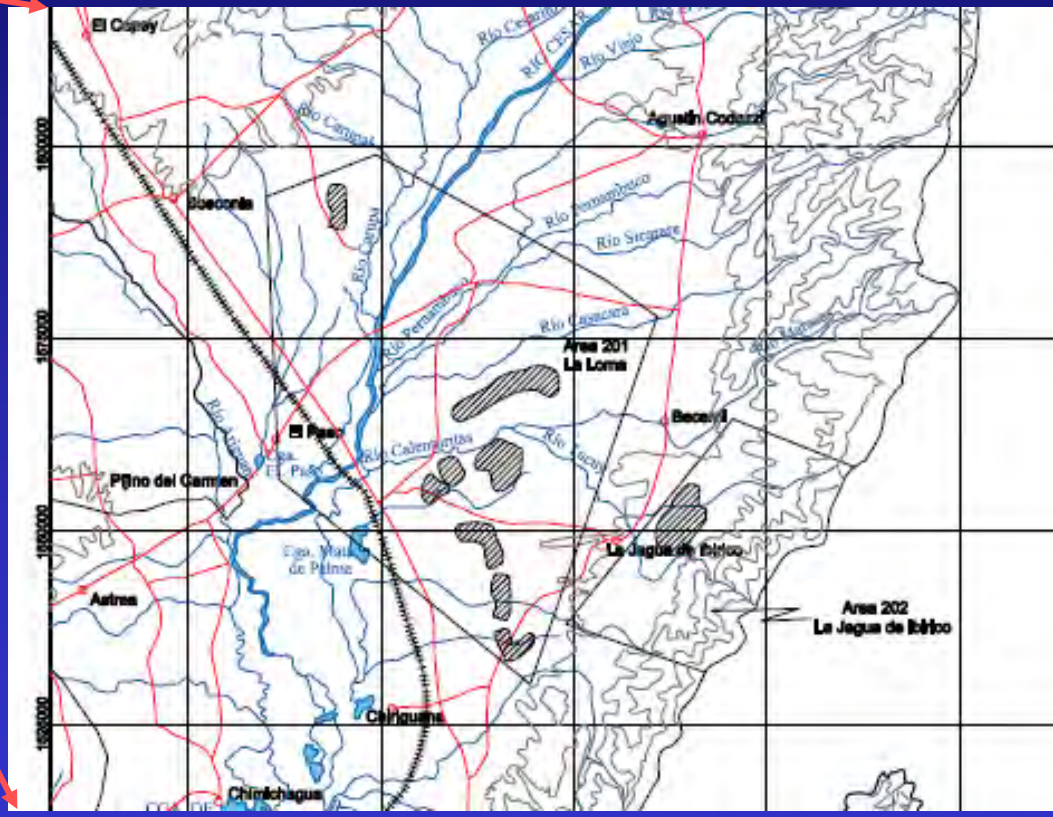


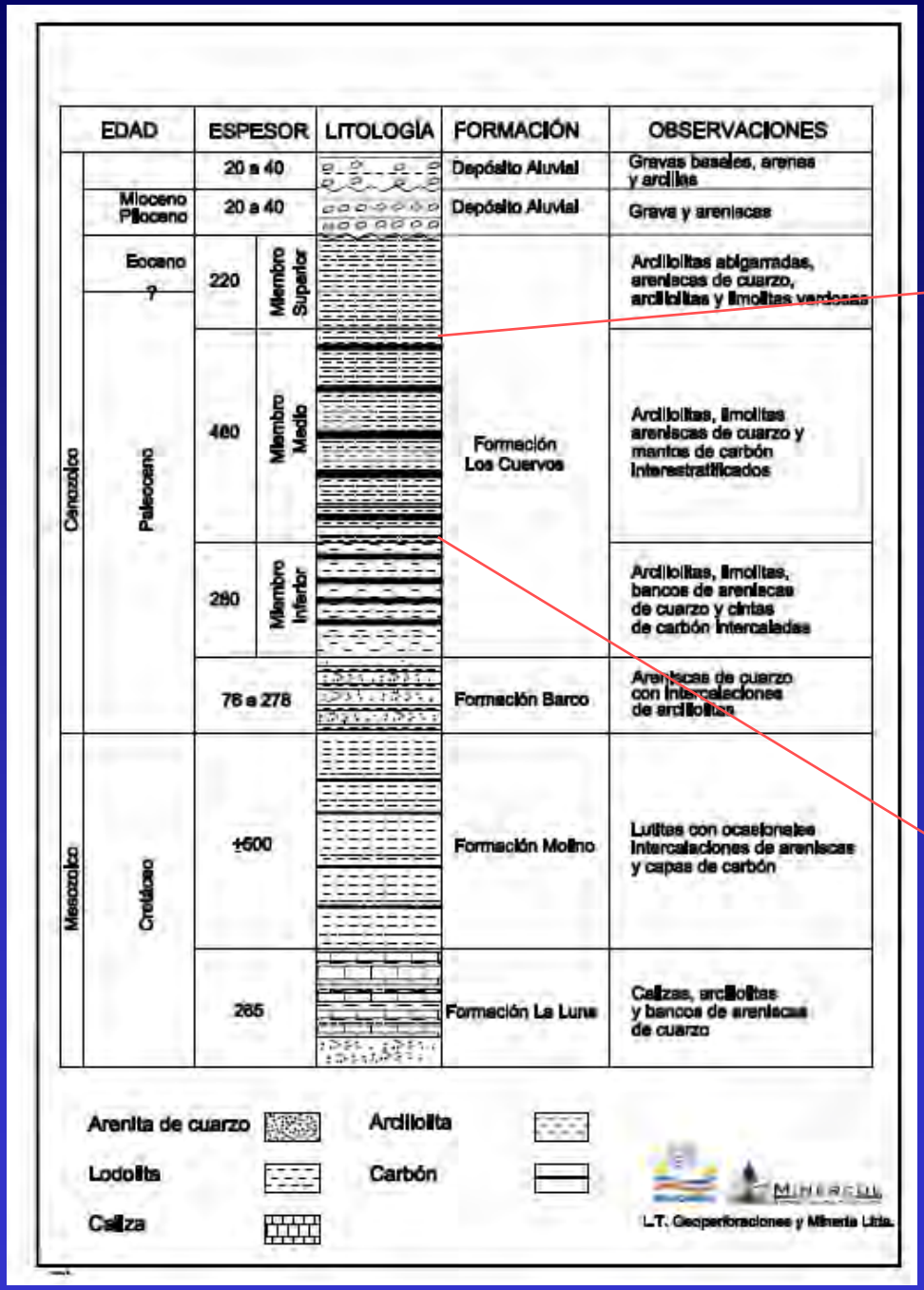
2D Geochemical Model of the Seismic line CV 89 1100 Ranhería Sub-Basin



Location of Coal-fields In the Cesar sub-basin





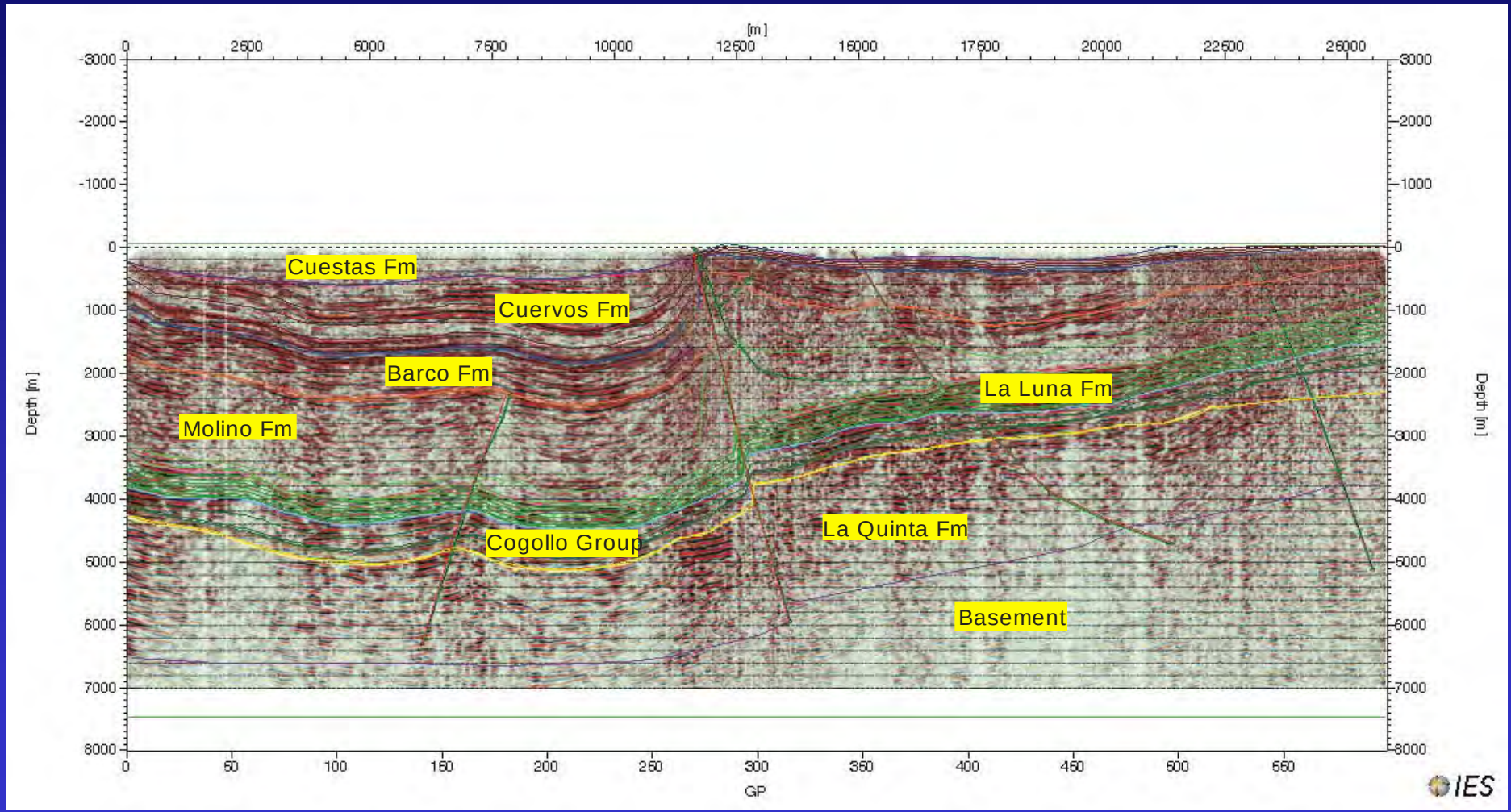


Cesar Sub-basin
Cuervos Formation
Paleocene

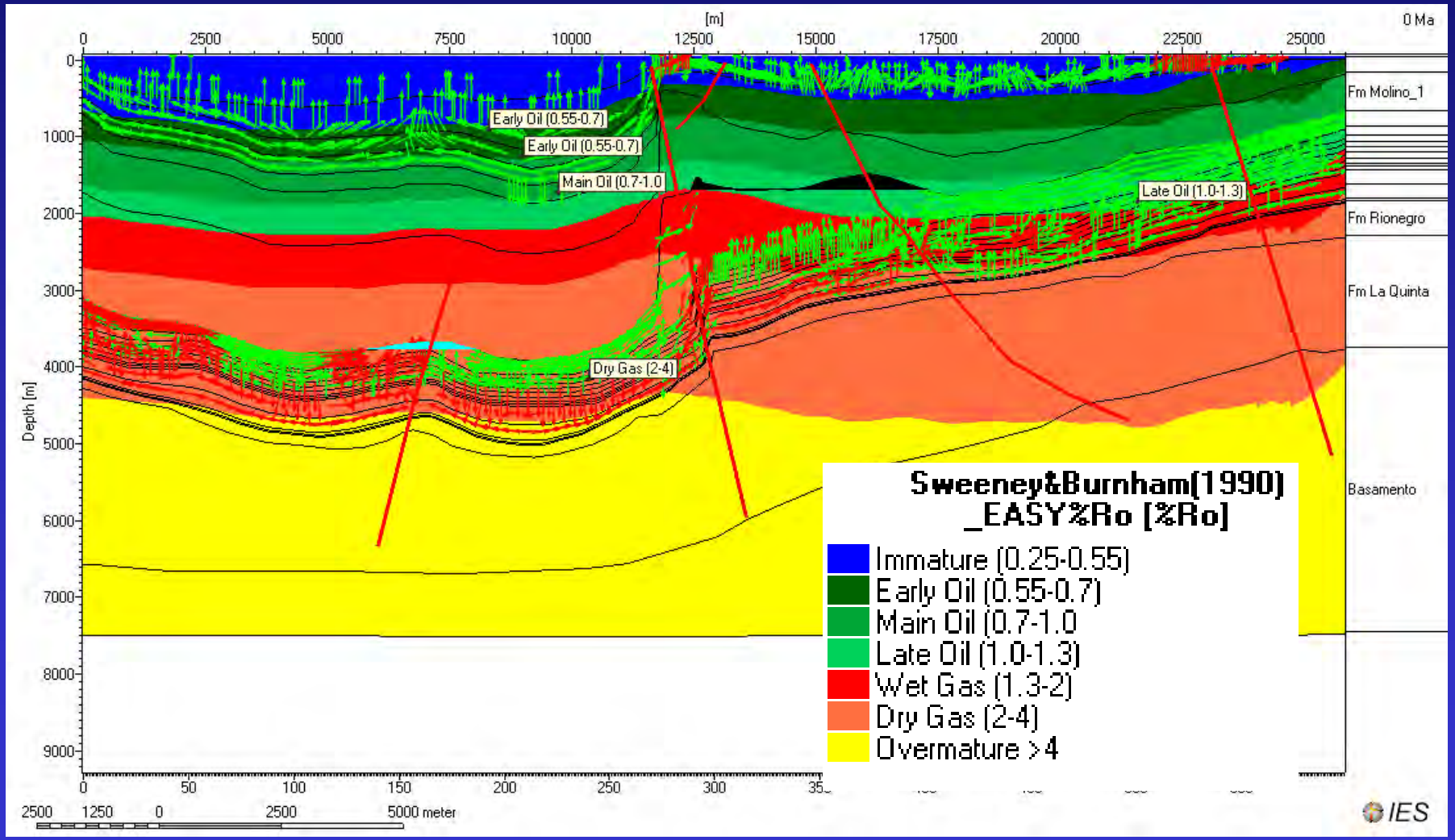
Net coal thickness
Up tp 40 meters

Coal Rank
High to Medium
Volatile Matter
Bituminous
Ro 0.5 -0.8%

SEISMIC LINE CR 88- 1200. CESAR SUB-BASIN



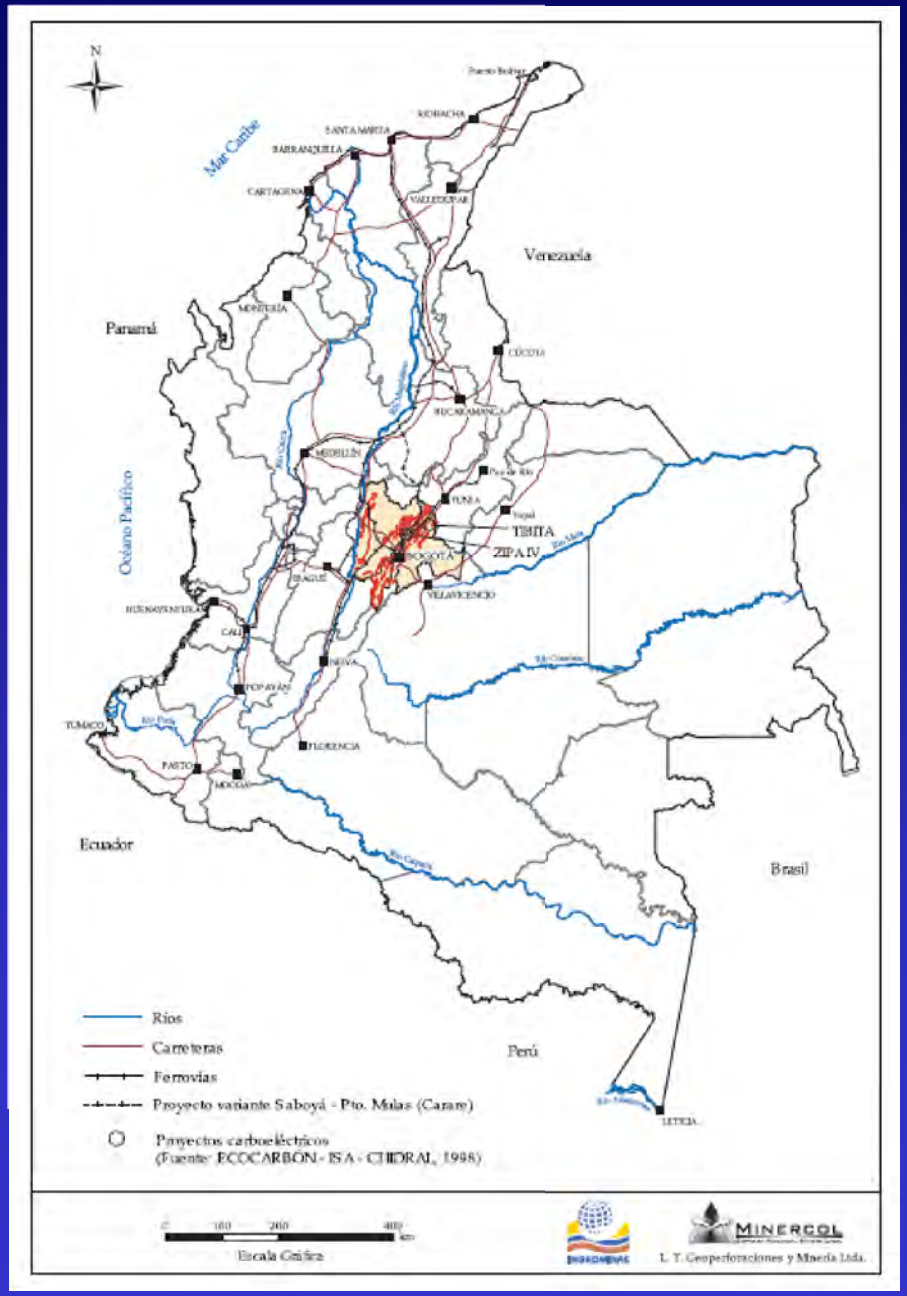
2D Geochemical Model of Seismic Line CR 1200 Showing Maturation stages and Hydrocarbon Migration Pathways Cesar Sub-basin



CBM Potential in The Eastern Cordillera

Guaduas Formation
Coal rank:
Bituminous and Sub-bituminous coals
Ro 0.45 to 1.0%

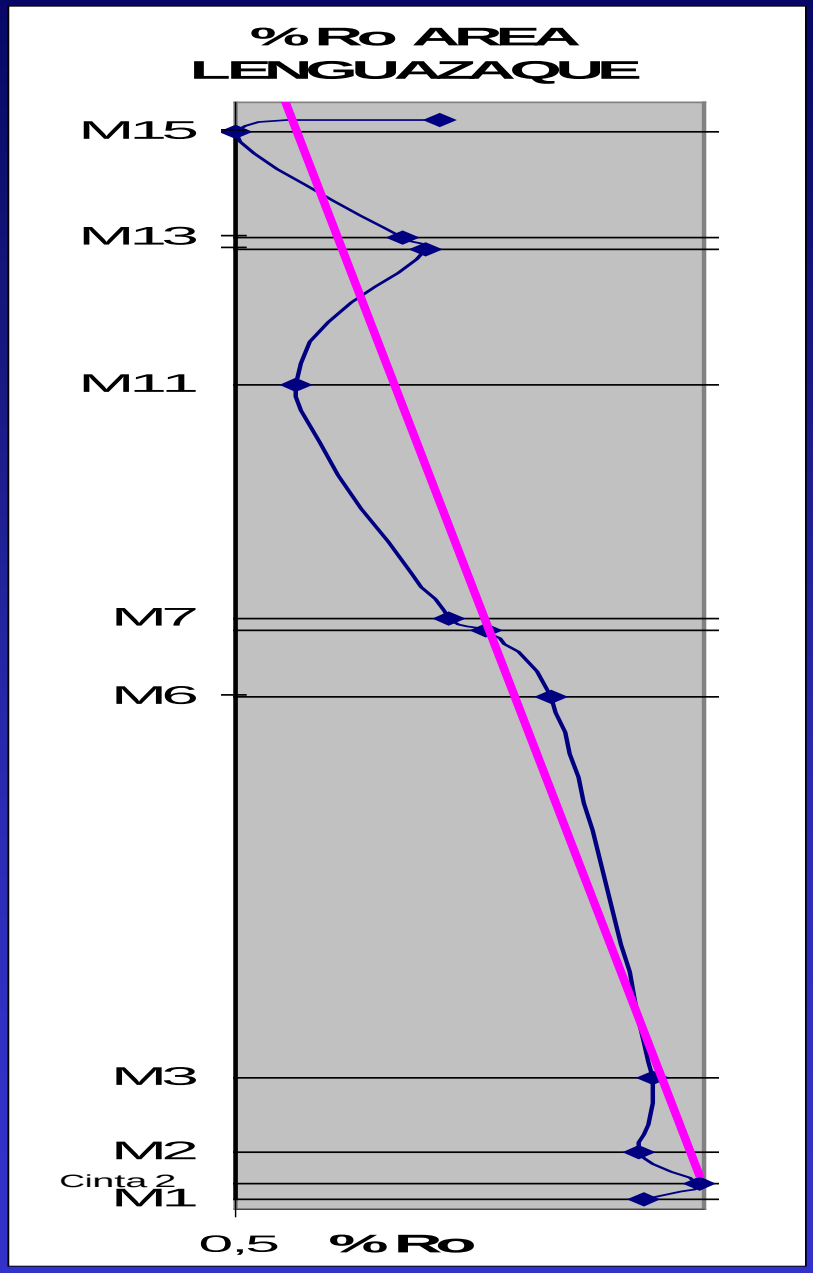
CBM resource:
6 TCF



Bogotá Plateau

Coal Rank
Sub-bituminous
To
L V. Bituminous

Ro 0.5 to 1.5%



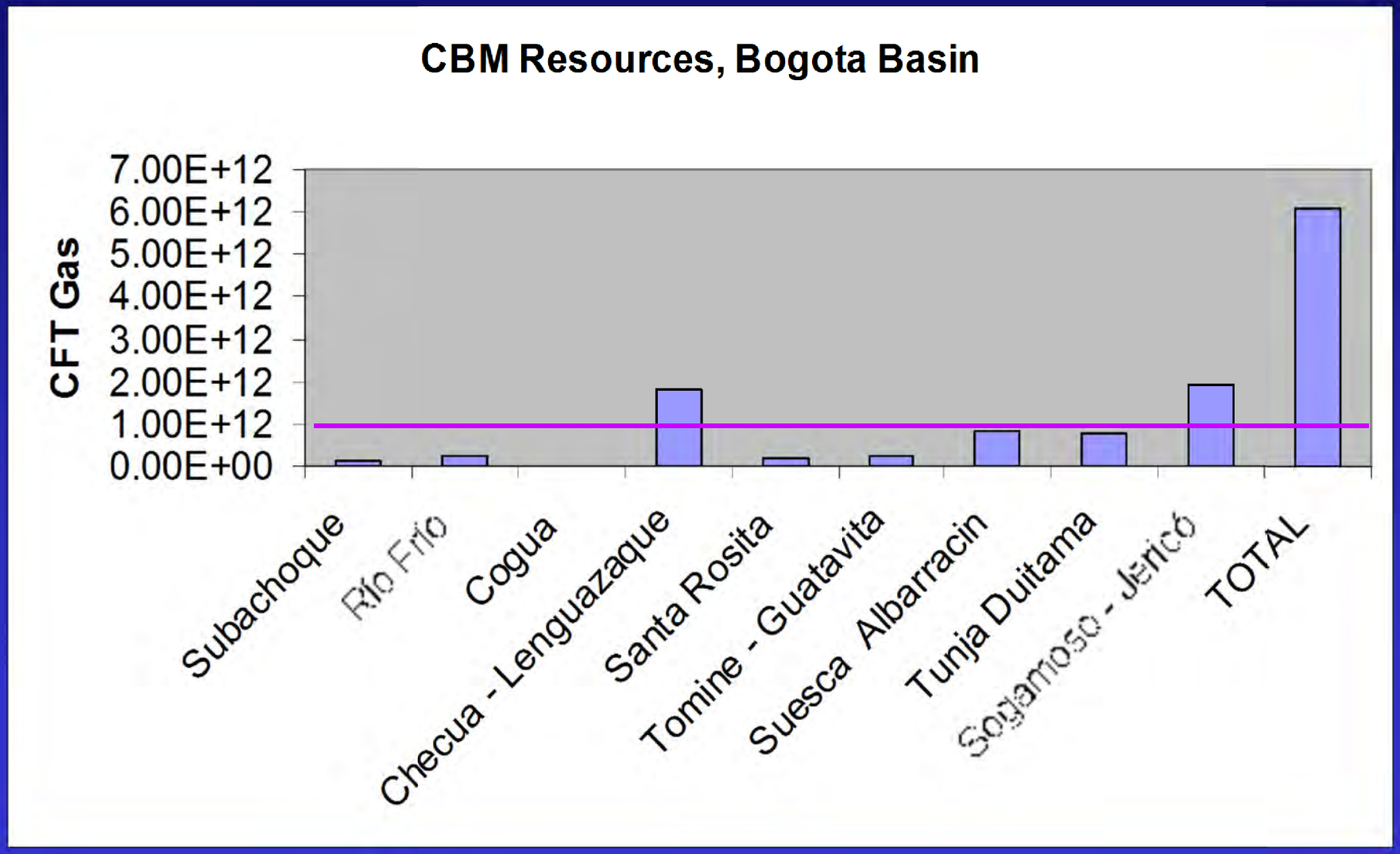
Guaduas Formation

Ro vs. Depth profile

Ro Range:
0.45 to 0.95%

Depth range 500 m

COALBED METHANE RESOURCE IN THE BOGOTA BASIN

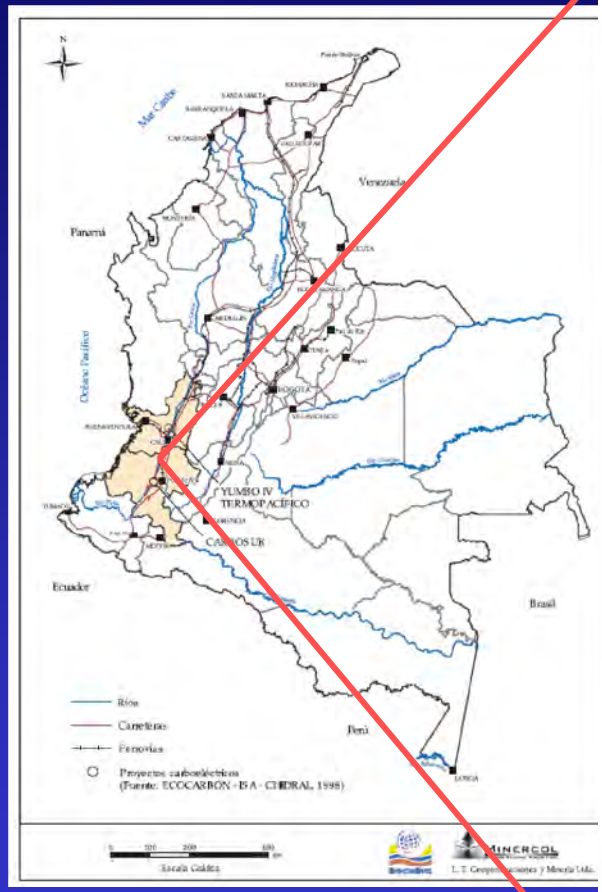


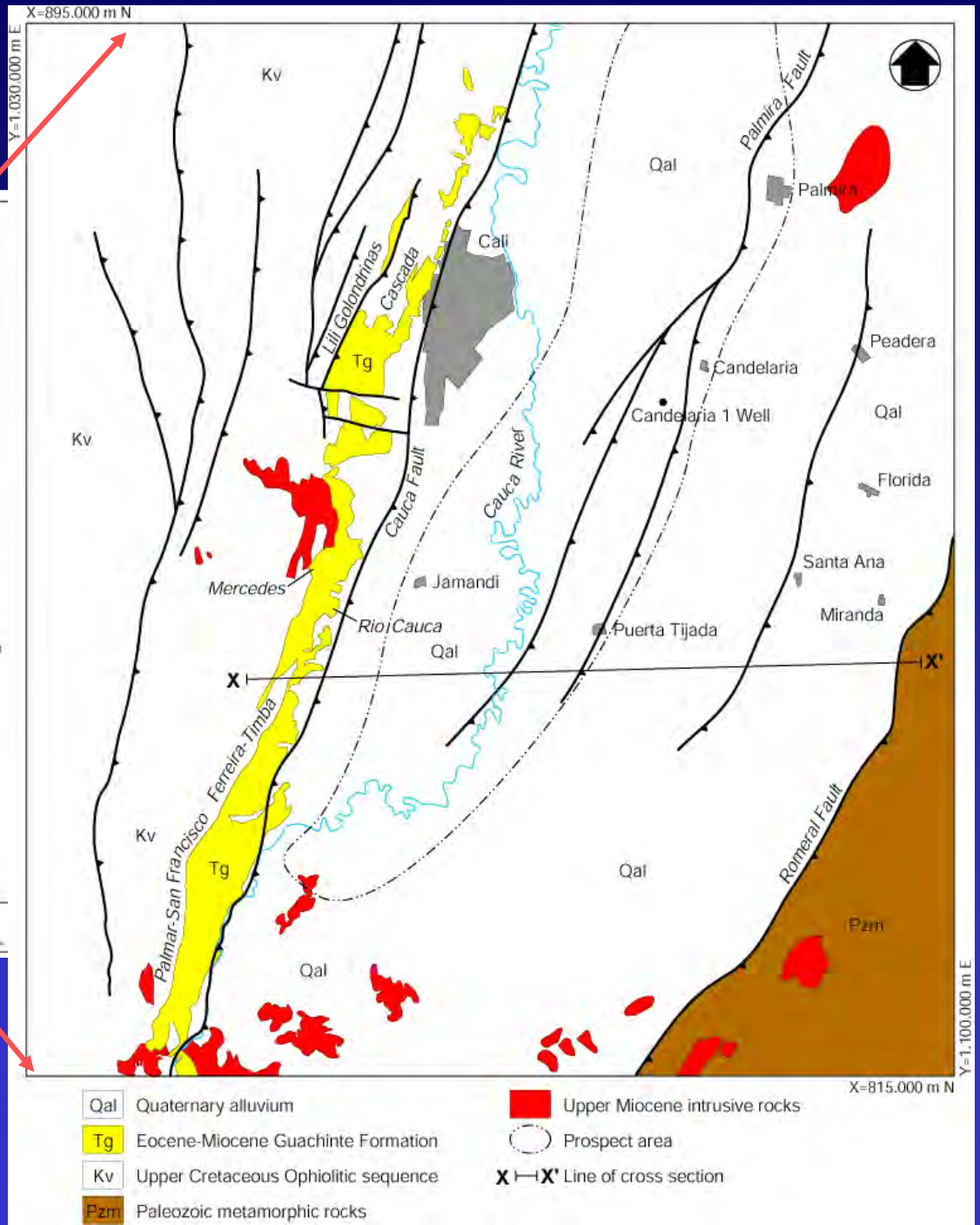
Cauca Basin CBM Potential

Coal-bearing Fms:
Guachinte
Ferreira

Coal rank:
Bituminous and Sub-Bit. Coals

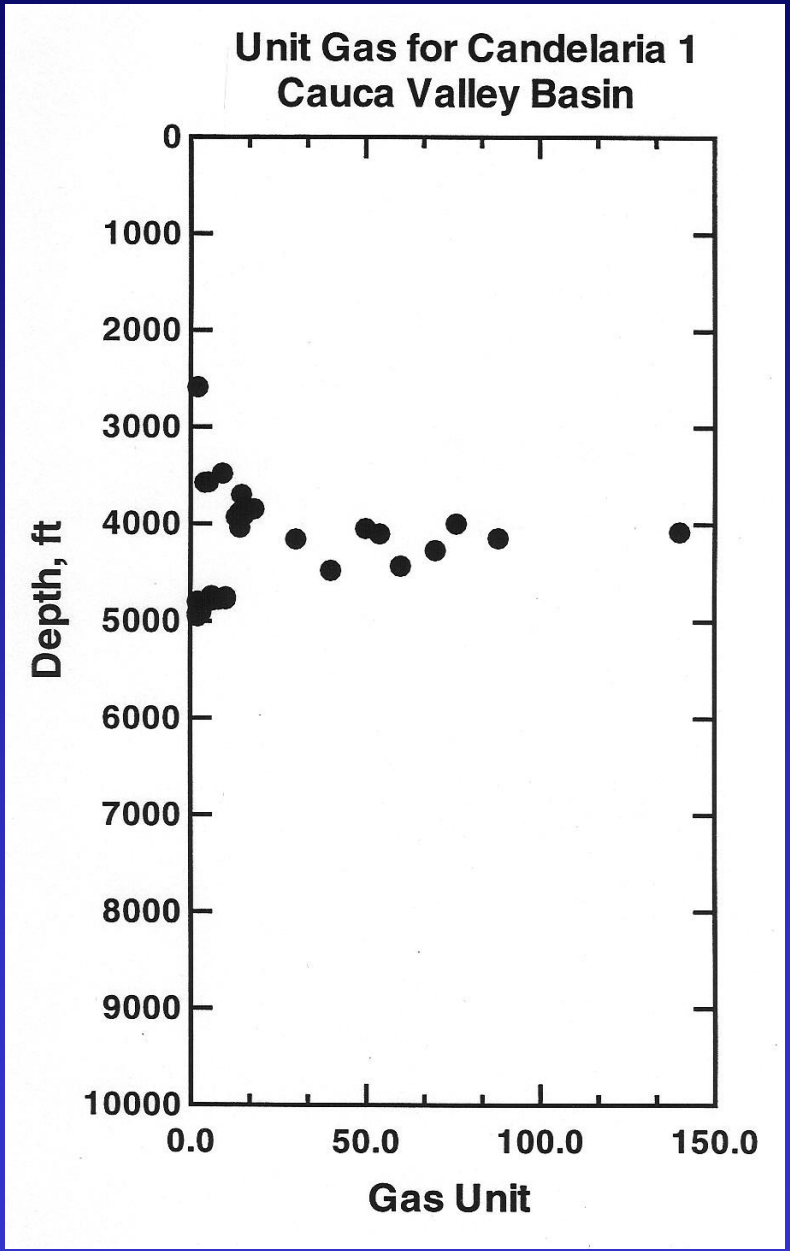
CBM resource
1.9 TCF

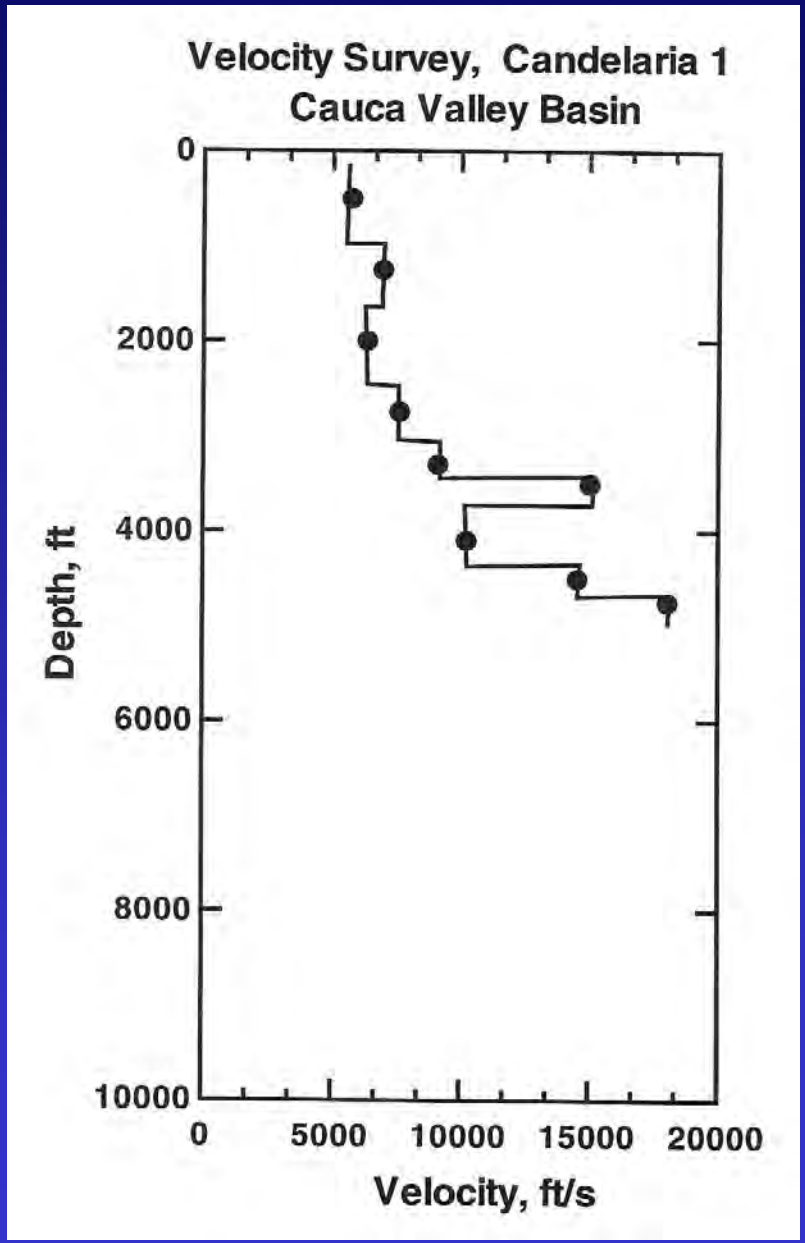

Mar Caribe
Venezuela
Panamá
Océano Pacífico
Ecuador
Brasil
Perú
YUMBO IV
TERMOPACÍFICO
CASTILLOS UK
Ríos
Carreteras
Ferrovias
Proyectos carboeléctricos
(Fuente: ECOCARBON - ISA - CHIDRAL, 1998)
MINERCOL

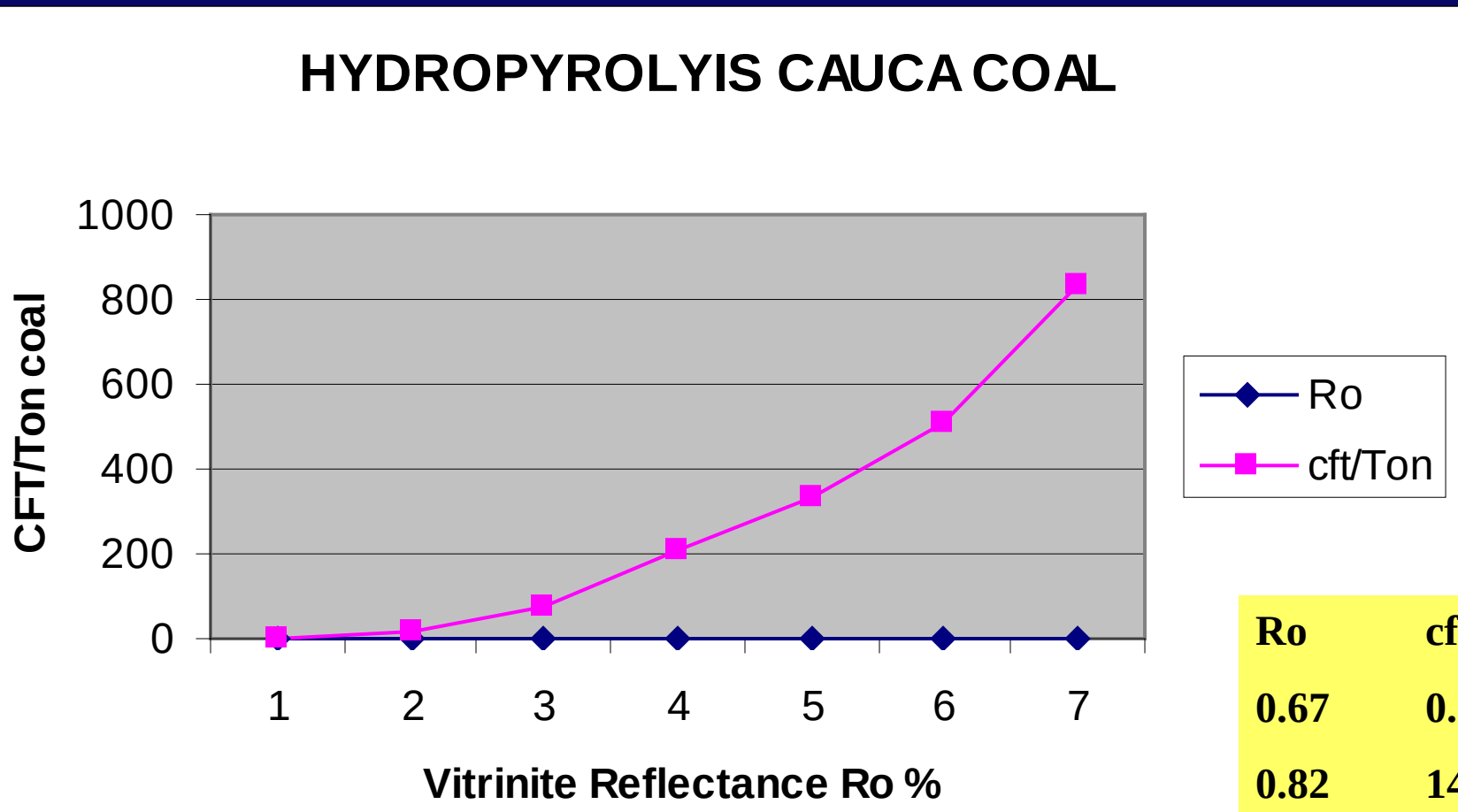

X=895.000 m N
Y=1.030.000 m E
Y=1.100.000 m E
X=815.000 m N
Kv
Qal
Tg
Pzm
Palmira Fault
Palmira
Cali
Lili
Golondrinas
Cascada
Peadera
Candelaria
Candelaria 1 Well
Florida
Santa Ana
Miranda
Puerta Tijada
Jamandi
Mercedes
Rio Cauca
Cauca Fault
Cauca River
Palmar-San Francisco
Ferreira-Timba
Romeral Fault
X
X'
Qal Quaternary alluvium
Tg Eocene-Miocene Guachinte Formation
Kv Upper Cretaceous Ophiolitic sequence
Pzm Paleozoic metamorphic rocks
Upper Miocene intrusive rocks
Prospect area
X X' Line of cross section

Stratigraphy of the Cauca Valley Basin Colombia

Gas shows in the Candelaria -1 well associated with coal seams







Ro	cft/Ton
0.67	0.25
0.82	14.32
0.93	72.45
1.1	207.76
1.31	337.23
1.52	510.26
1.67	833.24

Gas Generation Potential of the Guachinte Fm. coal at different Ro values Determined with Hydropyrolisis experiments

CBM Resources in Colombia

Cuenca	Edad	Rango Carbon	CBM
			Tcf
Cerrejon	Paleoceno	Bituminous	2.8
La Jagua	Paleoceno	Bituminous	2.1
Altiplano Cund	Maaestrichtian	Sub-Bituminous to Bitum.	6.0
Valle Cauc	Oligoceno	Sub-Bituminous to Bitum.	1.9
Magdalena Me	Maaestrichtian	Bituminous	0.1
Catatumbo	Paleo.-Oligo.	Sub-Bituminous to Bitum.	0.2
San Jorge	Oligo.-Mioceno	Lignite to Sub-Bitum.	4.3
Antioquia	Oligo.-Mioceno	Sub-Bituminous to Bitum.	0.1
		TOTAL resources	17.5

CONCLUSIONS

The Coalbed methane resources in Colombia can reach 17.5 TCF. This figure is conservative because in some basins deep coal seam at depth greater than 300 m were not taken into account.

The main coal-bearing areas with the largest CBM potential are Maestrichtian-Paleocene in age and are located in the Cesar, Rancheria, and Bogotá basins.